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(54) **[Name of Invention]** Functional micropiles and their manufacturing methods

(57) **[Summary]**

[Problem] To provide functional micropiles and their manufacturing methods:
In order to conceal certain skin parts that have changed in quality or color, chemical improvement or physical covering up has been used to provide skin functions (adding colors, beautifying, protection from ultra-violet rays, etc.) to skin or stratum corneum in everyday life. The purpose of this invention is to provide micropiles and their manufacturing methods so that the aforementioned treatment can be done without causing pain, and with substantially enhanced level of simplicity, safety, and effectiveness.

[Solution]
Micropiles and manufacturing methods:
A micropile has a structure of cylinder type pile/piles arranged on a base platform. A micropile is mainly made of saccharine [sugar/saccharine??] that melts and disappears in the living body. It has functionally enhanced materials as its ingredient or as a part inside. When a micropile touches skin, it establishes a route to stratra cornea of skin and inserts the functional material only to the strata cornea of the skin of skin without causing pain, and in a simple, safe, and effective manner.

[Diagram here]

[Range of Patent Claims]

[Claim 1] A functional micropile whose special attribute is a structure in which a square-cylinder pile or a circular-cylinder pile is placed on top of the base platform. The cross section of the cylinder is either a square or a circle with one side [of a square] or a diameter of 0.1 – 100 μm. Length of the pile is 0.5 - 500μm.

[Claim 2] A functional micropile whose special attribute is a structure in which a rectangular-cylinder type pile or an oval- cylinder type pile is placed on top of the base platform. The cross section of the cylinder is either a rectangle or an oval shape with a short side [of a rectangle] or a shorter diameter of 0.1 – 100 μm. Length of the pile is 0.5 - 500μm.

[Claim 3] A functional micropile described in Claim 1 or 2 whose special attribute is that the square/rectangular-cylinder or circular/oval-cylinder is mainly made of saccharine [sugar/glucose??] that dissolves and disappears in the living body.

[Claim 4] A functional micropile described in Claims 1 ~ 3 whose special attribute is that when the micropile, which has functional material either as an ingredient or as its part, touches the skin, a route to the strata cornea of the skin will be established and the functional material will be inserted only to the strata cornea of the skin.

[Claim 5] A functional micropile described in Claims 2 ~ 4 that can control the direction of breakage by means of the fact that the shape of the cross section is rectangular or oval.

[Claim 6] A functional micropile described in Claims 1 ~ 5 whose special attribute is that there is a neck/narrow part in the middle of the micropile and that the micropile can break easily at the neck, leaving only the top part of the micropile in the strata cornea of the skin.

[Claim 7] A functional micropile described in Claims 1 ~ 5 whose special attribute is that there is a difference in thickness of the pile with the top half being thin and the bottom half being thick and that the pile breaks easily at the part where thickness difference exists, leaving only the top part of the pile in the strata cornea of the skin.

[Claim 8] A functional micropile described in Claims 1 ~ 7 whose special attribute is that the top part of the micropile is in the shape of a knife, making the insertion into the strata cornea of the skin easy.

[Claim 9] A functional micropile described in Claims 1 ~ 8 whose special attribute is that it has a structure in which a micro-container with sealed-in functional material is placed inside.

[Claim 10] A functional micropile described in Claim 9 whose special attribute is that the top of the micropile is in arrowhead shape which has a micro-container inside. When removing a micropile after contacting the skin, the arrowhead-shaped part breaks easily due to spring needle effect and only the micro-container will remain in the strata cornea of the skin.

[Claim 11] A functional micropile described in Claims 1 ~ 8 whose special attribute is that an empty space to contain the functional material is created along the center axle of the micropile.

[Claim 12] A functional micropile described in Claims 1~ 11 whose special attribute is that it has a structure that enables control of the amount of functional material to remain in the strata cornea of the skin by placing multiple functional micropiles on the base platform.

[Claim 13] A functional micropile described in Claims 1~ 12 whose special attribute is that it has a structure in which a reflection prevention block larger than the bottom of the micropile is installed to prevent the base of the micropile from being exposed to excessive light that is reflected off of the base platform surface.

[Claim 14] Manufacturing methods of functional micropiles described in Claims 1~ 11 include each of the following procedures: (a) X-ray lithography procedure in which micropile pattern is formed by applying synchrotoron-radiating X-ray to X ray-sensitive resin, (b) Mold manufacturing procedure that manufactures micropile molds by using electro-molding procedure to produce the reverse image of the micropile pattern, (c) Injection molding procedure to mold a micropile by injecting into the mold the material mixed with functional ingredients, (d) Outer-packaging assembly procedure to make the functional micropile into a product.

[Claim 15] Manufacturing methods of a functional micropile described in Claim 14 whose special attribute is that X-ray sensitive resin has poly methyl methacrylate (PMMA) in it.

[Detailed Description of Invention]

[0001]

[Technology of Invention] This invention is about functional micropiles and their manufacturing methods. A micropile is a treatment device that provides surface layer and/or strata cornea of the skin with beautification effects and/or functional effects in an easy, safe, and effective manner.

[0002]

[Conventional Technology] Until recently, most technology has provided surface of the living body, such as skin or mucous membrane, with beautification or functional effects by applying liquid type or powder/paint type material. With conventional technology, target of the function is limited to the surface of the living body. Due to sweat, washing, accidental contact with alien substances, or weather, etc., the function of conventional technology loses its effect and the function reproduction behavior has to be repeated every day and by hand. Therefore, not only is that method rather limited in its ability to replicate the function, but also is inferior in terms of simplicity, safety, and effectiveness. In addition, the liquid type that purports to penetrate deep in the skin had to rely on osmosis phenomenon such as diffusion. As a result, it is difficult to control the depth of osmosis accurately.

[0003]

[Problems to be solved by this Invention] Simplicity, safety, and effectiveness of the function reproduction procedure mentioned above is the important issue. For example, providing skin functions in everyday life is difficult due to the cost and time required. At the same time, dealing with the changes in the strata cornea is a difficult task. A variety of methods has been attempted to remove changed parts of skin either chemically or through nutrition. However change itself is a sign of complex phenomenon of the living body and it is also related to aging, making it not only a challenge of the past but also an ever lasting challenge of daily life well into the future.

[0004]
[Means of Solution] The goal of this patent is to conceal the skin parts that have changed in quality or color either by chemical improvement or physical covering up. As a result of serious research and development efforts, we, inventors, invented high-precision, functional micropiles. Using these micropiles, we succeeded in providing beautification effects and/or functional effects to the surface layer and/or strata cornea of the skin without pain and in a simple, safe, and more effective way, thereby solving the problems of conventional methods. In addition, we invented effective manufacturing methods of the functional micropiles and succeeded in making their industrial production possible.

[0005] Use aforementioned micropiles for skin function treatment, one just needs to press the micro-size or nano-size, high-precision, functional piles, which has functional materials such as cosmetics in it, against skin. The functional material will remain only in the strata cornea of the skin without causing pain and with stability until replacement of skin occurs due to skin regeneration, which is 1 week to 10 days. This way, one does not need to repeat skin function treatments daily and repeatedly, thereby providing convenience in everyday life. Secondly, using saccharine [sugar/glucose??] as the ingredient of the micropiles enhances the safety level. Even if micropiles remain in the strata cornea of the skin or go too deep into the blood vessel by mistake, the saccharine [sugar/glucose??] dissolves immediately, making it extremely safe. In addition, with various designs of the micropile structure for each different type, it is very possible to leave micropiles in the strata cornea of the skin without causing pain. With the multiple-micropile structure, the amount of functional material to remain can also be controlled even with one shot on the skin, thereby significantly enhancing efficiency.

[0006] Processing technology for high-precision procedures at the level of μm size or even smaller has already been established in the field of micro-machinery. This invention applied that technology and succeeded in making treatment devices of nm ~ μm size that is inserted into skin. Consequently, it became possible to create basic physical structure for cutting, pinching, penetrating, maintaining, etc. to work on the strata cornea of the skin for high-precision procedures in a simple manner. Especially, this invention improved the micro-processing technology exhibited in the Patent Disclosure, Patent Application No. 20000-347103 (Name of Invention: Material processing methods and devices using X-ray) and applied X –ray with ultra short wave length from synchrotoron to make nm size, high-precision processing easy.

[0007] To summarize this invention, its major points are as follows:
(1) A functional micropile whose special attribute is a structure in which a square-cylinder pile or a circular-cylinder pile is placed on top of the base platform. The cross section of the cylinder is either a square or a circle with one side [of a square] or a diameter of 0.1 – 100 μm. Length of the pile is 0.5 - 500μm. And
(2) A functional micropile whose special attribute is a structure in which a rectangular-cylinder type pile or an oval- cylinder type pile is placed on top of the base platform. The cross section of the cylinder is either a rectangle or an oval shape with a short side [of a rectangle] or a shorter diameter of 0.1 – 100 μm. Length of the pile is 0.5 - 500μm. And
(3) A functional micropile described in above paragraph 1 or 2 whose special attribute is that the square/rectangular-cylinder or circular/oval-cylinder is mainly made of saccharine [sugar/glucose??] that dissolves and disappears in the living body. And
(4) A functional micropile described in above paragraphs 1 ~ 3 whose special attribute is that when

the micropile, which has functional material either as an ingredient or as its part, touches the skin, a route to the strata cornea of the skin will be established and the functional material will be inserted only to the strata cornea of the skin. And
(5) A functional micropile described in above paragraphs 2 ~ 4 that can control the direction of breakage by means of the fact that the shape of the cross section is rectangular or oval. And
(6) A functional micropile described in above paragraphs 1 ~ 5 whose special attribute is that there is a neck/narrow part in the middle of the micropile and that the micropile can break easily at the neck, leaving only the top part of the micropile in the strata cornea of the skin. And
(7) A functional micropile described in above paragraphs 1 ~ 5 whose special attribute is that there is a difference in thickness of the pile with the top half being thin and the bottom half being thick and that the pile breaks easily at the part where thickness difference exists, leaving only the top part of the pile in the strata cornea of the skin. And
(8) A functional micropile described in above paragraphs 1 ~ 7 whose special attribute is that the top part of the micropile is in the shape of a knife, making the insertion into the strata cornea of the skin easy. And
(9) A functional micropile described in above paragraphs 1 ~ 8 whose special attribute is that it has a structure in which a micro-container with sealed-in functional material is placed inside. And
(10) A functional micropile described in above paragraph 9 whose special attribute is that the top of the micropile is in arrowhead shape which has a micro-container inside. When removing a micropile after contacting the skin, the arrowhead-shaped part breaks easily due to spring needle effect and only the micro-container will remain in the strata cornea of the skin.
A functional micropile described in Claims 1 ~ 8 whose special attribute is that an empty space to contain the functional material is created along the center axle of the micropile. And
(11) A functional micropile described in above paragraphs 1 ~ 8 whose special attribute is that an empty space to contain the functional material is created along the center axle of the micropile. And
(12) A functional micropile described in above paragraphs 1~ 11 whose special attribute is that it has a structure that enables control of the amount of functional material to remain in the strata cornea of the skin by placing multiple functional micropiles on the base platform. And
(13) A functional micropile described in above paragrapgs 1~ 12 whose special attribute is that it has a structure in which a reflection prevention block larger than the bottom of the micropile is installed to prevent the base of the micropile from being exposed to excessive light that is reflected off of the base platform surface. And
(14) Manufacturing methods of functional micropiles described in above paragraphs 1~ 11 include each of the following procedures: (a) X-ray lithography procedure in which micropile pattern is formed by applying synchrotoron-radiating X-ray to X ray-sensitive resin, (b) Mold manufacturing procedure that manufactures micropile molds by using electro-molding procedure to produce the reverse image of the micropile pattern, (c) Injection molding procedure to mold a micropile by injecting into the mold the material mixed with functional ingredients, (d) Outer-packaging assembly procedure to make the functional micropile into a product. And
(15) Manufacturing methods of a functional micropile described in above paragraph 14 whose special attribute is that X-ray sensitive resin has poly methyl methacrylate (PMMA) in it.

[0008]
[Actual implementation form of Invention] Actual implementation form of functional micropiles in this invention is described in, though not limited to it, the following.

[0009] Functional micropiles provide highly-precision technology to insert functional cosmetics only

to strata cornea of the skin. To provide sufficient amount of the functional material intended, base platform with multiple micropiles is used. For example, we recommend, though not limited to it, inserting the functional material mix into the strata cornea of the skin by stamping the skin with a square-shape base platform of 1 cm^2 with over 10,000 functional micropiles by tapping lightly, and let the mix implement its function. In terms of the shape of a single micropile, cylinder types with square bottom, rectangular bottom, circular bottom, or oval bottom, as well as their equivalents in cone shape are recommended.

[0010] At the time when the intended function treatment is implemented, we recommend, though not limited to it, the functional material to be contained only in the tip of the functional micropile.

[0011] In addition, we provide, as another example, a simple tape with multiple functional micropiles arranged on it. We recommend, though not limited to it, implementing intended function by attaching the tape with the functional micropiles facing and touching the skin.

[0012] We recommend, though not limited to it, using the type of saccharine [sugar/glucose??] that is already in practical use, such as maltose, as the main ingredient of functional micropiles or micro-containers in this invention.

[0013] We recommend, though not limited to it, making the surface structure of the saccharine [sugar/glucose??] functional micropile water-repellant in order to prevent penetration of moisture and prevent the moisture in the air from making it soft.

[0014] We recommend, though not limited to it, using water-soluble cosmetics or medically used functional cosmetics as sulfuric acid valium for the functional material mix to be included in the functional micropiles.

[0015] We recommend, though not limited it, using the functional micropiles for exposed surface such as face or hands/feet.

[0016] We recommend, though not limited to it, making the base platform of functional micropiles in this invention with X-ray sensitive resin. More specifically, we recommend X-ray sensitive resin with PMMA (poly methyl methacrylate) and materials that can endure the physical or chemical impact such as X-ray or heat during manufacturing process. In addition, to support the entire base platform of the functional micropile, we recommend, though not limited to it, using adhesive type support materials such as adhesive plaster tape or medical tape.

[0017] As for the manufacturing method of the functional micropiles in this invention, the first step is to apply syncroton radiating X-ray to the base platform made of X-ray sensntive resin with PMMA. This application is done through a mask with a specific pattern. Master pattern is formed by removing the parts exposed to X-ray after development. A mold with a reverse image of the master pattern is made through an electro-molding procedure. Afterwards, injection process is used to mold the reverse image of the mold (a product that has the same pattern as the master pattern), i.e., functional micropile. During this injection process, saccharine [sugar/glucose??] mixed with functional materials is used to form the shape.

[0018] In other words, these manufacturing methods of functional micropiles have as its special

attributes the following procedures: (a) X-ray lithography procedure in which micropile pattern is formed by applying synchrotoron-radiating X-ray to X ray-sensitive resin, (b) Mold manufacturing procedure that manufactures micropile molds by using electro-molding procedure to produce the reverse image of the micropile pattern, (c) Injection molding procedure to mold a micropile by injecting into the mold the material mixed with functional ingredients, (d) Outer-packaging assembly procedure to make the functional micropile into a product.

[0019]
[Implementation Examples] Implementation examples of this invention will be described below in concrete terms, but not limited to those cases.

[0020] Case No. 1
To cover the facial parts where skin quality or color has changed, multi-functional micropiles of this invention was used. The goal was achieved by making functional micropiles mixed with functional cosmetics in the same color as the skin of the patient. Manufacturing method of this invention was used. When the area to be covered is large, the goal can be achieved easily by using multiple micropiles. As for the size, proper length of the functional micropile is 50μm~ 70μm considering that the thickness of the strata cornea of the skin of skin is 100μ ~ 300μ. Tip of the micropile should be under 5μ to be used without causing any pain. Using PMMA, we made a square base platform with one side being 1 cm. We made 10,000 maltose micropiles (we mixed functional cosmetics in the same color as patient's skin at the ratio of 20% of the total weight) with a diameter of 10μ and length of 60μ in a cylinder shape with a circle bottom and placed them on top of the base platform. Pressing this device lightly against the birthmark on the face, we tapped it lightly with hand for about 10 times and removed it. As a result, the 1 cm^2 area of the birthmark disappeared visually. The patient said, "I did not feel any pain during the procedure at all."

[0021] Case No. 2
Recently, there have been more incidents of patient switching by mistake at large hospitals. Especially, when newborn babies are switched by mistake, it is a real tragedy. If there is some sort of a mark on the body, this kind of problems can be easily prevented. Many people tried to create visible signs using ribbons, writing with a pen, labels, etc. However, these devices can be easily lost by the behavior of the patient. If we put a mark in the strata cornea of the skin, the mark will stay there safely regardless of the patient behavior. Multi-functional micropiles can create a sign and can be extremely useful in preventing patient switching by mistake. So, using PMMA, we made a square base platform with one side being 0.5 cm. We made 2,500 maltose micropiles (we mixed red food coloring at the ratio of 15% of the total weight) in a 20μ diameter and 70μ length cylinder shape with a circle bottom and placed them on top of the base platform. Pressing this device lightly against the arch of the foot of a newborn baby, we tapped it lightly with hand for about 10 times and removed it. As a result, a red square mark of 0.5 cm for each side was made with ease on the arch of the foot. The newborn baby who was the patient in this case slept through the procedure peacefully. The red mark disappeared completely about 2 months later.

[0022] Case No. 3
In the entertainment business, improvement of stage make-up has been pursued with vigor without stopping. Despite this situation, demand for ability to replicate is very high among cosmetics technologies. This invention provides a method that makes it possible to replicate the make-up easily and quickly. Used along with the conventional method of applying make-up on the surface, this

invention can provide a possibility for new means of expression and support the creation of a new art culture. So, using PMMA, we made a circular base platform with 0.3 cm diameter. We made 3,000 maltose micropiles (we mixed black ink at the ratio of 10% of the total weight) with a diameter of 15μ and length of 60μ in a cylinder shape with a circle bottom and put them on top of the base platform. Pressing this device lightly against the patient's back of the hand, we tapped it lightly with hand for about 10 times and removed it. As a result, a black mole of 0.3 cm circle was made with ease on the back of the hand. The patient said, "I did not feel any pain during the procedure at all." The black mole disappeared completely about 3 months later.

[0023] Case No. 4
Sun-block lotion/cream is widely used to be applied on the face. However, it is often not very effective because it comes off easily due to sweat, contact with alien substance, etc. If sun-block lotio/cream can be inserted in the shallow layer of the face or body, using multi-functional micropiles of this invention, its effect will definitely last for a few days, producing effects much superior to the conventional lotion/cream type products. So, using PMMA, we made a circular base platform with 1 cm diameter. We made 5,000 maltose micropiles (we mixed organic UV- ray blocker, Par-sole MCX, at the ratio of 1% of the total weight) with a 10μ diameter and 70μ length cylinder shape with a circle bottom and placed them on top of the base platform. Pressing this device lightly against the patient's back of the hand, we tapped it lightly with hand for about 10 times and removed it. After that, we had the patient naturally expose the hand to the direct Sun outdoors for one month to check the amount of the tan. As a result, it was determined that a circle of 1 cm diameter on the back of the hand was not tanned compared to the surrounding area. The patient said, "I did not feel any pain during the procedure at all." The Sun-block effect disappeared about 2.5 months later.

[0024]
[Effect of Invention] According to this invention, it is possible to insert functional material into the strata cornea of the skin by leaving the tip or part of the micropiles by using very small functional micropiles made with the mixture of functional materials like coloring cosmetics or functional liquid like UV absorbent. The ingredient of the micropiles that remain in the skin is saccharine [sugar/glucose??] and causes no harm to the living body. The function within the strata cornea of the skin remains for a few days up to a few months. In addition, insertion of functional materials into the strata cornea of the skin can be done without causing any pain and in a simple, safe, and effective manner.

[Brief description of Diagrams]
[Diagram 1] Simple diagram of an example of a single-pile functional micropile described in Claim 1 of this invention.
[Diagram 2] Simple diagram of an example of a functional micropile with a narrow neck described in Claim 6 of this invention.
[Diagram 3] Simple diagram of an example of a functional micropile with a difference in diameter// described in Claim 7 of this invention.
[Diagram 4] Simple diagram of an example of a functional micropile with asymmetrical cross section described in Claim 2 of this invention.
[Diagram 5] Simple diagram of an example of a functional micropile with micro-container described in Claim 9 of this invention.
[Diagram 6] Simple diagram of an example of a functional micropile with capillary empty space described in Claim 11 of this invention.

[Diagram 7] Simple diagram of an example of functional multi-micropiles described in Claim 12 of this invention.
[Diagram 8] Simple diagram of an example of a functional micropile with reflection prevention block described in Claim 13 of this invention.

[Description of Numbers]
1. Single functional micropile
2. Base platform
3. Area of thickness difference
4. Narrow part/neck
5. Micro-container part
6. Capillary part
7. X-ray reflection prevention block

[Diagram 1] [Diagram 2] [Diagram 3] [Diagram 4]
[Diagram 5] [Diagram 6] [Diagram 7] [Diagram 8]